SPACE SCIENCES LABORATORY

PART II

ON BEING INFORMED BY A COMPUTER-BASED MANAGEMENT INFORMATION SYSTEM: A STUDY IN INVOLVEMENT AND APPRECIATION

by
E. Burton Swanson

December, 1971

UNIVERSITY OF CALIFORNIA, BERKELEY

PART II

ON BEING INFORMED BY A COMPUTER-BASED MANAGEMENT INFORMATION SYSTEM:

A STUDY IN INVOLVEMENT AND APPRECIATION

by
E. Burton Swanson

Internal Working Paper No. 9

December, 1971

This research was supported in part by the National Aeronautics and Space Administration under General Grant #NGL 05-003-404 under the University of California.

Social Applications of Resource Information
Space Sciences Laboratory
University of California
Berkeley

Chapter 2. A Study: The SQC Engineering Group and Its Activity Reporting Information System

The study presented here was conducted over a period of approximately six months, the last half of the year 1970. Individual and organizational names are fictitious, but, hopefully, reality has been otherwise preserved.

The purpose of the study was to investigate the worth of the theoretical ideas presented in the previous chapter. Specifically, to test the set of hypotheses regarding user appreciation and involvement in a real-world situation. As might be expected, during the course of the study, new ideas emerged to supplement and transform our initial conceptions. The organization of this chapter reflects this fact.

The first four sections present the context within which the formal data collection and analysis took place. The "SQC Engineering Group" is described first, and, following this, a routine description of the "Activity Reporting Information System" is given. In the subsequent two sections, an attempt has been made to present the history and sociology of the MIS in a manner which captures two important themes which developed from the research. Although these themes

constitute "conclusions", they will be stated now in order to direct the reader in assimilating what is to follow.

The themes are these:

(2.1) An MIS originates and develops within an evolutionary context, a constantly changing milieu of organizational and technological possibilities.

(2.2) The realization of an MIS is the product of sustained individual and group commitment in an otherwise indifferent (or hostile) social environment.

Neither of the above will surprise those who have experience in the design and implementation of information systems. Both, however, must be appreciated in order to fully grasp the MIS environment for our research. Thus, their manifestation in the Activity Reporting Information System is extensively covered.

A historical account of events is used to present the basis for the above themes, and quotations from interviews are interspersed in the "story" to give the reader the flavor of its human dimension. No attempt has been made to fully portray the personalities of those involved, and the reader should assess the

quoted remarks in terms of our themes only. It would be unfair to do otherwise.

The fifth section of this chapter presents our formal analysis of MIS appreciation and involvement.

The final section lists our conclusions. The reader may wish to scan these before proceeding with the details of the chapter.

2.1 The SQC Engineering Group

SQC Engineering is a department of more than 200 employees of a large international manufacturer of complex electronic equipment. The department, referred to as a "group" within the formal organizational structure, is responsible for the production quality control of one of the company's West Coast manufacturing plants, employing several thousand individuals.

The Group's personnel are primarily engineers and technicians, supplemented by various forms of clerical support. The bulk of this manpower consists of "indirect" employees whose time is charged by the Accounting department to overhead accounts. However, the Group does employ line inspectors as "direct" employees whose time is charged to the particular products involved.

SQC Engineering management consists mostly of technically qualified engineers, many promoted from within.

A formal organization chart of the Group is shown on the following page. Three "programs" (second-level departments) are organized within the Group. The Product Quality Control Program watches over the principal manufactured products. The Process Quality Control program is responsible for intermediate parts and components, and certain second-line products. In addition, one of its departments is charged with the administrative support of the Group as a whole. Finally, the Measurement Technology Program services the other two programs by providing the sophisticated technology required for quality control measurements.

One important quality control function resides outside the SQC Engineering Group. The vast majority of parts for the company's products are purchased from other organizations. The responsibility for the quality control of purchased parts lies with the Purchasing Group and its Purchasing Engineering Program. Since the quality control of purchased parts is not unrelated to that for finished products, there are strong informal bonds between Purchasing Engineering and the SQC Engineering Group. The Purchasing

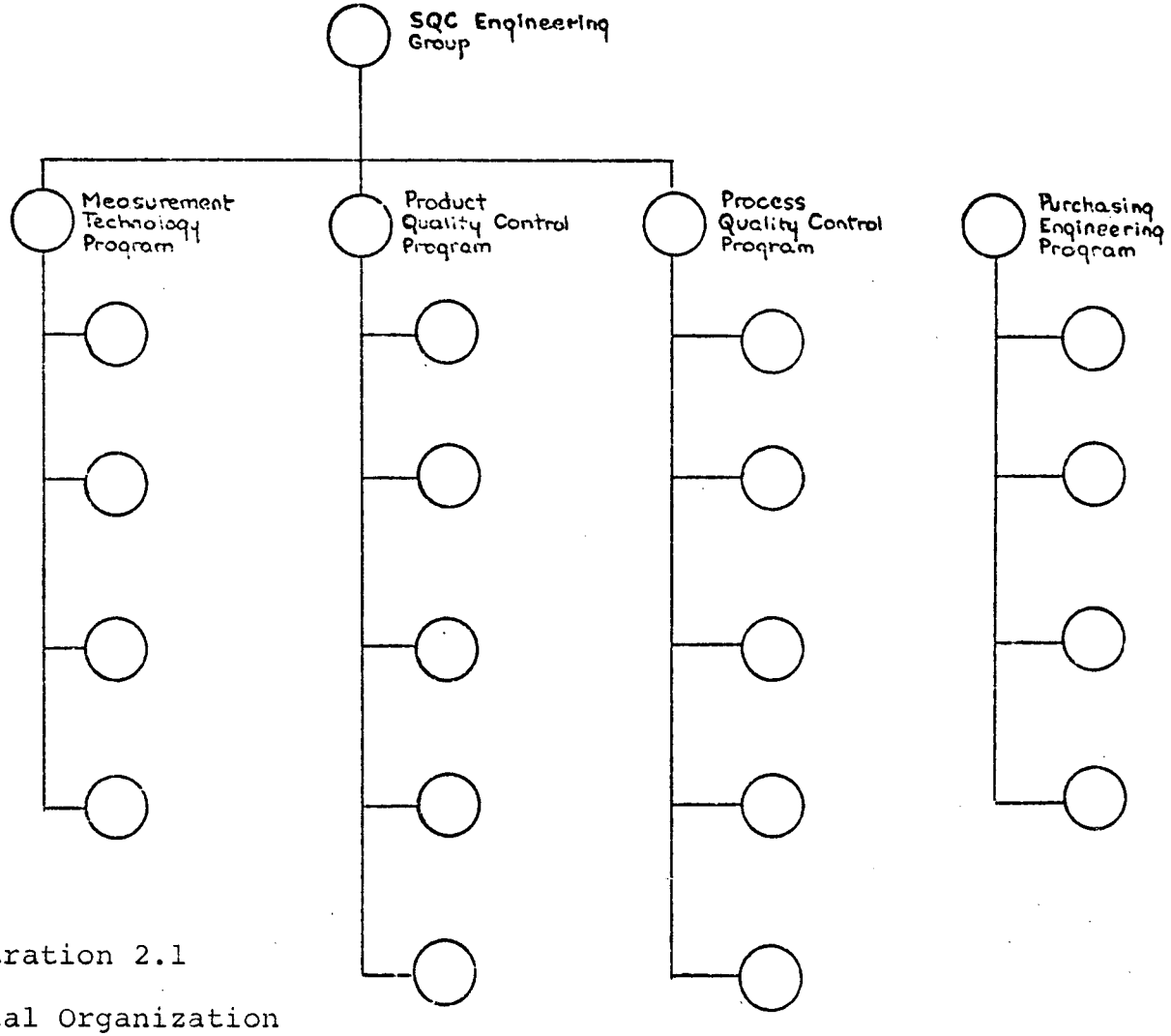

Illustration 2.1

Departmental Organization

SQC Engineering Group

Engineering Program is shown on our organization chart as an adjunct to SQC Engineering.

Apart from its formal management structure, SQC Engineering also has "product managers," engineers with informal management responsibility for the quality control of specific products. Since the quality control effort for a product crosses formal departmental lines, informal channels of communication have evolved to supply the required degrees of coordination. However, there is some doubt whether the concept of product management has been borne out in practice.

While the entire Group is located at one plant site, the various members are scattered throughout six buildings. This dispersion no doubt leads to a segmentation in the informal communications, although the employees move rather freely between buildings.

2.2 The Activity Reporting Information System

SQC Engineering employs an "Activity Reporting Information System" (known as "ARIS")[1/] as a vehicle for self-management. The Group's budget, apart from capital expenditures, consists predominately of personnel wages. Thus, the allocation of manpower to the various tasks

---

1/ A name conjured up in my imagination, with apologies to any other systems similarly titled.

at hand constitutes a significant management problem. The ARIS system gathers data on the planned and actual work activity of the Group's members, and makes it available to management on a "need to know" basis. Each department manager has access to the data within his formally defined responsibility; that is, he is limited to the departments and personnel reporting to him. In addition, the product managers have access to all work activity data pertaining to their product responsibility. These data often cut across formal organization lines.

ARIS utilizes an IBM-developed computer program system known as "Management Information System/360" (or, more popularly, as "MIS/360")[1/] to make its data accessible to "generalized" inquiry from remote terminals.[2/] The feature of generalized inquiry allows the terminal operator to specify the format and content of his report at the terminal by means of a query language. The MIS/360 program system has been designed specifically to facilitate the generation of reports in unanticipated forms. This form of computer

---

1/ Not an IBM product, but a "Type III" program. For details, see the documentation for contributed program 360D-06.7.009, published by the IBM Corp.

2/ IBM 2741 typewriter terminals and 2260 cathode ray tube (CRT) display stations.

technology is relatively new, and represents the latest attempt to "move the computer closer to the user."

ARIS makes two data files available for management inquiry. The first, the Activity Status File, contains work activity data from the most recent 13 weeks, at a level of detail which includes the activity records of individual Group members. The second file, derived from the first, maintains an 18 month summary of work activity at the department level. This second file is referred to as the Activity History File. Both files are relatively simple in structure, and are described completely in Appendix 2.1 to this chapter.

Despite the limited nature of the ARIS files, there is no practical limit to the number of unique reports which can be produced through generalized MIS/360 inquiry. Some examples:

(i) A summary of man-hours charged to a given machine type during a recent month, broken down by employee skill code.

(ii) An exception listing of those machine types for which the actual man-hours charged exceed the budgeted man-hours, for each month, over a one-year period.

(iii) A profile of the man-hours charged by a given employee to various work activities during each week of the current month.

(iv) A listing of the man-hours charged by a given department to various machine types, for each month, during the most recent six months.

A system flowchart for ARIS is shown on the following page. This chart shows each of the processes which make up the ARIS data processing activity. In terms of our earlier description of management information systems, this activity constitutes the data base maintenance and report generation components of the system. The Weekly Update Program, Monthly Update Program, and MIS/360 File Load Program all serve the data base maintenance function. The MIS/360 Inquiry Programs serve the report generation function.

Data origination is a human activity within ARIS, and is not shown on the system flowchart. The membership of SQC Engineering records its work activities on Activity Reporting Cards which update the Activity Status File on a weekly basis. These data are supplemented by two other forms of card input: Activity Description Cards and Product Description

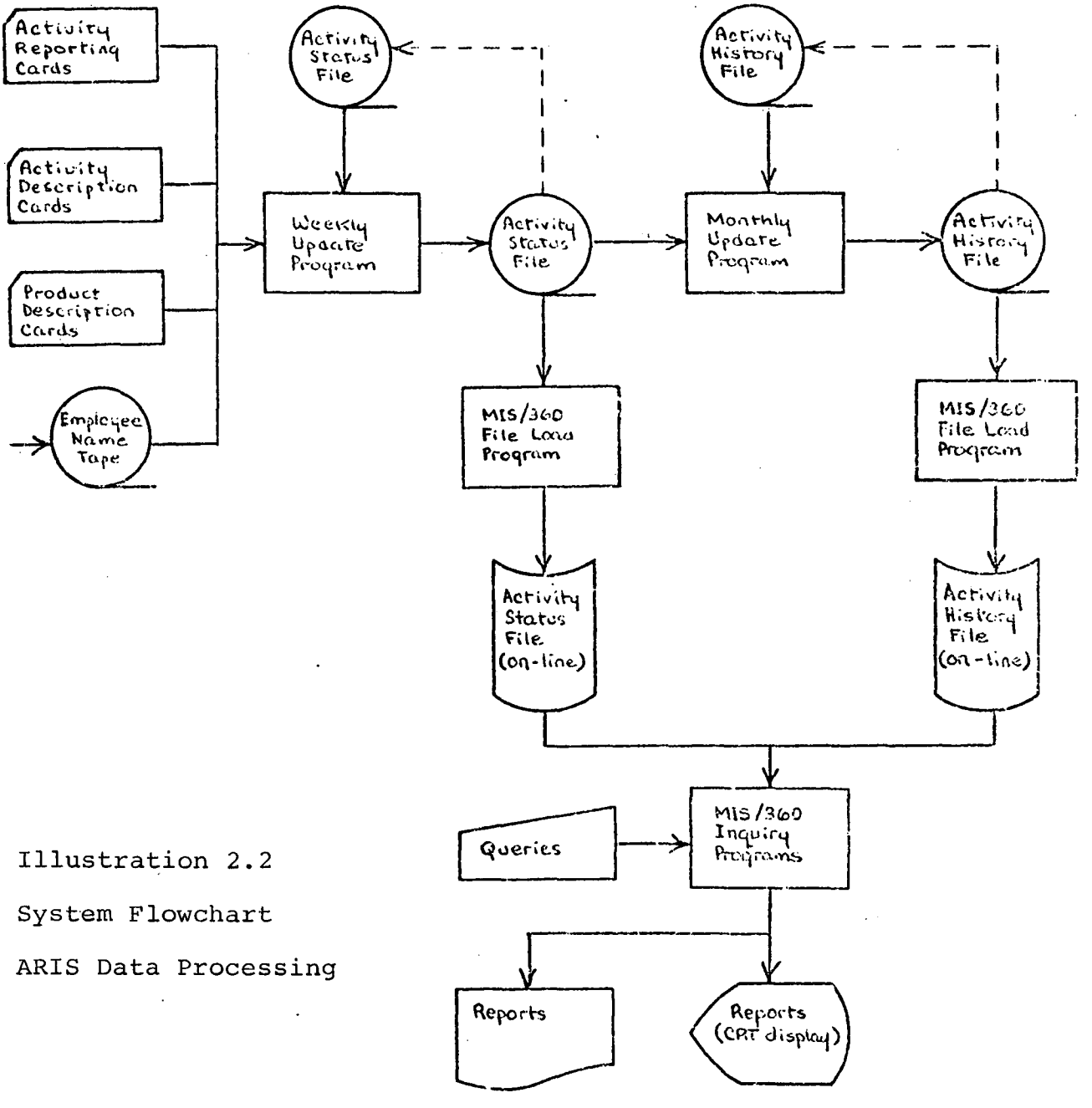

Illustration 2.2

System Flowchart

ARIS Data Processing

Cards; and by an Employee Name Tape, available as the output of another data processing application. The supplemental card input is provided by ARIS specialists rather than by the Group membership at large.

MIS/360 inquiry into the ARIS data base takes place from terminals scattered throughout the plant. Security provisions restrict inquiry privileges to those defined to have the "need to know." A prospective inquirer must supply MIS/360 with his "security code." This code allows the inquirer to access a given set of data files in a given fashion. Each prospective user of ARIS is assigned his own security code. During the course of our study, 46 individuals had personal access to the ARIS data base. Others had indirect access, delegated by their management.

The MIS/360 inquiry process is characterized by a conversational interaction between the inquirer and the report generation process. Each query entered by the user produces a report, and each report may provoke another query. The report generation process must interpret each query it receives, and the user must interpret each report. The resulting inquiry loop was shown in our schematic of a management information system in the previous chapter. Active ARIS inquirers

averaged between 8 and 26 queries per terminal sitting during the course of the study.

All queries entered are recorded by MIS/360, which maintains an Inquiry History File of user activity. This extensive record served as the data base for our own inquiry into ARIS use.

2.3 ARIS In An Evolutionary Perspective

ARIS is both a successor to earlier efforts to measure the work activity of indirect personnel, and a predecessor to the planned systems of the future. In a real sense, there is no beginning to the story, and there is likely to be no end. Nevertheless, we can attempt to trace its evolutionary development.

Mr. R. B. was hired by the SQC Engineering Group in 1967, and was assigned responsibility for the development of "administrative applications" (i.e. management systems) within the Group. Broadly speaking, he was to look for systems to "better able. . .[us] to control our resources." Since the salaries of Group employees constituted 90% of the budget apart from capital expenditures, it was natural to look at the problem of manpower management.

Several existing systems were investigated. Each of these systems required indirect employees to

record their work activities in a form amenable to machine processing, indicating how much of their time was being spent on particular projects, what types of work were being performed, and so on. At the same time, the employees were to plan their future work as well. Thus, over time, a history of data was accumulated which purported to measure an organization's success in planning and accomplishment. At the least, this was to lead to more "realistic" planning.

None of the existing systems had ever achieved notable success. The management reports were generated in a batch-processing environment (transactions were accumulated and processed on a weekly or monthly basis), and the resulting reports generally gathered dust on managers' desks. In such situations, employees often lost interest in providing the required input data. In one notable case, an engineer simply photo-copied his input datum, and reported the same work activity each week without attracting anyone's attention.

The existing systems were largely the results of Industrial Engineering efforts within the Company. The system developed by the local Industrial Engineering Group was found by Mr. R. B. to be "unworkable" and without flexibility. There was no self-discipline to the system (i.e. the input data tended to degenerate

in quality), and there was no possibility of aggregation of data above department level. Efforts to encourage the Industrial Engineering Group to develop a better system failed.

While the Industrial Engineering Group was generally responsible for work measurement, it was the Systems and Programming Group which implemented the systems in the form of computer applications. R. B. decided to seek support from this group directly. In August of 1968, "[we] made a lot of noise and got the attention of the Systems and Programming Group." Mr. J. N., a computer systems analyst, was assigned to support the SQC Engineering Group in its development of a new work measurement application.

R. B. and J. N. took another look at the Industrial Engineering application. Although the reports were unacceptable, the format for input data appeared adaptable to their needs. It seemed possible that a new reporting methodology might make the system workable. Then, according to R. B., "they (the Systems and Programming Group) pulled this thing called MIS/360 out of the hat."

MIS/360, a computer program system for the IBM System/360 product line, had been introduced in the Systems and Programming Group in the summer of 1968.

It allowed existing data files to be loaded to direct access storage devices, and accessed from remote terminals by means of a query language. It was (and still is) seen by many individuals to be the wave of the future in computer data processing applications.

The proponents of MIS/360 within the Systems and Programming Group vigorously sought applications for their software system. Such applications were needed to "justify" it in the eyes of management, for the system imposed a heavy additional overhead to an already burdened computer system. Thus, in late 1968, the MIS/360 advocates joined with R. B. and J. N. to advance their common interests.

R. B., still working alone within SQC Engineering, originated the design specifications for the new application. As he recalls, "I was the guy who told J. N. what we wanted, when we wanted it, and how we wanted it. . . . The specs we are [now] operating to. . .were all of my specification."

But progress was slow. "The problem, from the beginning, was keeping [them] busy on the thing, because it was obvious, to me, anyway, that it had a low, relatively low, priority." Other plant problems required the primary attention of the Systems and Programming Group. In particular, the Financial and

Accounting Group was receiving crisis-atmosphere support, and the Controller did not view the efforts of SQC Engineering in a favorable light. According to one observer, "He [the Controller] saw SQC Engineering as trying to milk his cow."

Support for the SQC Engineering application continued on a token basis until Mr. K. H. arrived on the scene as Mr. R. B.'s Program Manager. Within two days of the managerial change, R. B. made a presentation to K. H., explaining what he was trying to do. It was a successful effort. "He thought it was really great. He even applauded me, something that had never happened to me in a presentation before."

That K. H. would be favorably impressed should have come as no great surprise. Originally an industrial engineer, K. H. had been involved in attempts to measure indirect work activity as early as 1964. It was he who first sought to extend the local Industrial Engineering application beyond its limited scope. A planner by temperment, K. H. often pursued his data gathering and analysis in a single-handed fashion, literally as well as figuratively. His earlier efforts within SQC Engineering thus served as the groundwork for R. B.'s subsequent design of ARIS.

Furthermore, K. H. was capable of providing aggressive managerial leadership. As one of his colleagues puts it: ". . .being the kind of manager he is, [he] is not content to just have a general awareness of what people are doing, he wants to be a part of it, and he's either for it or against it. If he's against it, he's going to knock it off, if he's for it,. . .whatever it takes!" Thus, the stage appeared to be set for implementation progress.

But organizational change slowed development of the system to a near stop. R. B.'s immediate manager (reporting to K. H.) was promoted out of the plant, and R. B. moved up to take his place. R. B. "no longer had time" to push the ARIS development and, as he recalls, "Nothing was really happening in the Systems and Programming Group."

The system was not about to die, however. In December of 1969, K. H. and R. B. resolved to push for progress, and to "get a commitment" from Systems and Programming. Their efforts were successful, and by February of 1970, a test version of the ARIS MIS/360 application was "up and running." With the momentum toward implementation thus established, the system entered a "semi-operational" status in March, the following month.

A good deal of work remained to be done. In particular, the data files needed to be developed, and the prospective users of the system had to be "educated." On March 30, R. B. hired A. W. to take on this task. An experienced quality control engineer, A. W. was assigned a "planning and controls" responsibility; i.e., he assumed R. B.'s former position in SQC Engineering.

The proponents of ARIS held classes to introduce their clients to the system. SQC Engineering management was viewed as the clientele. "At the time we thought - who is the system for? It's for management people, mainly for management people and this other group we call 'product managers'." Thus, management was invited to attend the classes and learn how to use MIS/360 to interrogate the ARIS files. Most managers attended, although some sent various representatives, including some secretaries, much to the dismay of the designers. As one recalled, "Some managers didn't understand what the system was for, and they sent anyone. . . . We tried to make it clear it is a management system."

The classes were supplemented with various other forms of system promotion, including a series of newsletters which debuted in May, but succumbed the following month.

A good deal of emphasis was placed on data security. A memorandum of May 28 emphasized that "MIS/360 is a 'management' information system and. . . only those with a 'need to know' should have access to the data. . . .only managers and product managers [are] authorized access to the data." While this was to be expected, given the nature of the data, it was perhaps carried a little far. Another memorandum cautioned users: "When entering a security code on the 2260 display terminal the intensity (of the CRT) should be turned down until sign-on is completed."

As it turned out, however, the problem was not to keep the unauthorized in ignorance. The problem was to get the client to the terminal. The initial use of the system was somewhat disappointing. Few managers made inquiries, and the real use of the system was largely confined to the system proponents themselves. As A. W. remembers, "I <u>really</u> thought that a lot more people would use the system, because when we gave the classes, everyone was enthused,. . .and they thought it was great. [But] we had a lot of problems in the beginning. The system wouldn't be up, it wouldn't work, you couldn't get on, the file wouldn't be loaded, the data wouldn't be any good. I guess this discouraged some people. And others never really tried."

But the ARIS proponents persevered. A good deal of effort was spent in integrating the system into the organizational processes of SQC Engineering. (This will be discussed in detail in the following section.) At the same time, A. W. sought to shore up various technical features of the system. A whole series of proposed modifications were soon in the works: additional data elements, simplified code structures, and a completely revamped Activity Reporting Card format. Most of these changes implied additional support from the Systems and Programming Group, which was being cut back due to budgetary pressures within the company. As of today, i.e. the last days of 1970, the technological adaptation and extension of ARIS is proceeding with some difficulty.

* * *

A widening of our evolutionary perspective will shed further light on the development of ARIS. The SQC Engineering Group is, obviously, only one of the various manufacturing groups subject to potential work activity measurement. If we look at the plant as a whole, the limited nature of ARIS will become apparent.

Historically, the "direct" plant employees have always been subject to "labor claiming," i.e. recording the times spent on pre-defined manufacturing

operations. Direct labor hours are charged to product costs according to standard accounting procedures, and manufacturing management monitors its product costs by noting variances between "actual" and "standard" direct labor charges (and other costs considered to be "traceable" to the product). All "direct" employees, including inspectors within SQC Engineering, provide input to the automated accounting system which supports this.

On the other hand, the salaries of indirect employees are accumulated in various overhead accounts, and allocated to the products according to distribution ratios established by the Finance and Accounting Group.[1/] Traditionally, there is no accounting-based rationale to measuring the work activity of the indirect personnel. Thus, although an engineer may spend his entire work week on problems associated with a particular product, this fact is not "relevant" to the conventional (accounting) wisdom within the plant.

Such facts are, however, of concern to the management of manufacturing groups consisting primarily of indirect employees, e.g. SQC Engineering. These groups are engaged in continuing budgetary battles

---

1/ An oversimplification in the case studied, but necessary at this point to avoid confusion.

relating to their manpower needs. "Forecasts" of these needs are necessary for planning purposes. And since the manufacturing future is characterized in terms of production schedules, it is natural for management to explain their needs in terms of products and support activities.

Thus, there are, and have been, various attempts to implement work measurement systems (e.g. ARIS) in the indirect groups. An ultimate aim, however, is the design and implementation of a plant-wide system which includes both direct and indirect employees, and which satisfies management's felt-need for control, as well as the Controller's requirements for good accounting practice. An SQC Engineering manager puts it this way: ". . .we say, doggone it, are you a Controller or are you an accountant? Do you just want to make sure all the costs get put somewhere, or do you really want to control? . . . Let's distribute this burden on the basis of some criterion that is real, to <u>us</u>! ... We're not trying to tell the Controller how to do his job, but we say, almost in spite of what the Controller sees fit to measure and to use to distribute costs, we've got to know <u>more</u> than that!"

ARIS is therefore just a stepping stone toward the realization of this larger vision. Design efforts are already underway to supplant ARIS with a comprehensive plant-wide system for work activity measurement. From this point of view, ARIS is simply a "pilot" project. Thus, from our evolutionary perspective, we see the eventual demise of the system, as well as its origin.

2.4 The Sociology of ARIS Use

ARIS is now an ongoing system. Over 40 users have had inquiry privileges over a period of more than six months. In this section we will consider the character of ARIS use. We will be interested in identifying those individuals making terminal inquiries, i.e. those who use the system directly, as well as those who use the system indirectly, e.g. in receiving reports produced by others. In addition, we will seek to discover those organizational events which actually motivate use of the system.

We begin by expanding our organization chart to include all individuals in SQC Engineering with MIS/360 security-code access to the ARIS files. This is shown on the following page. All SQC Engineering managers are included in the group, as are the various

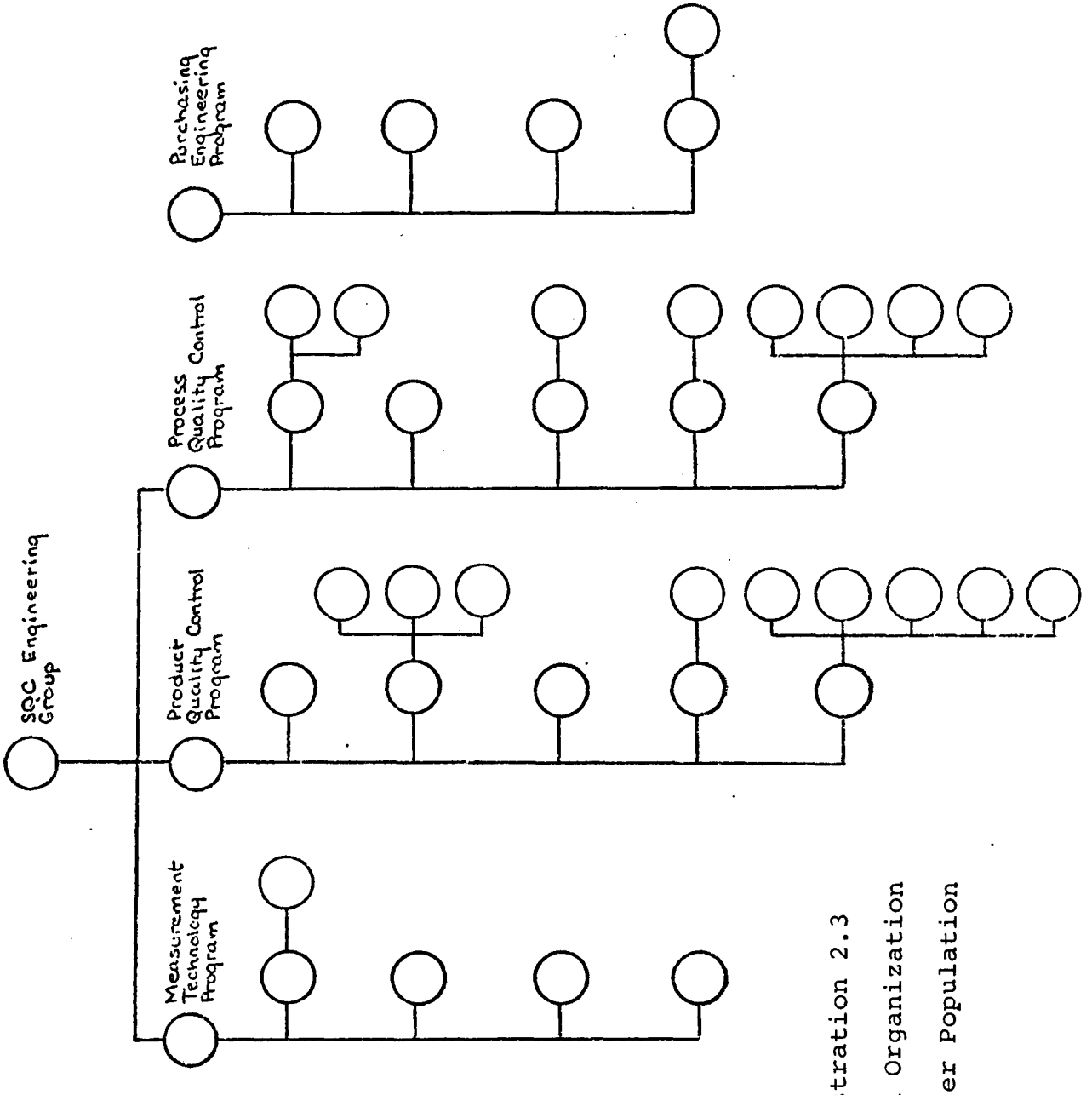

Illustration 2.3

Formal Organization

ARIS User Population

"product managers," and ARIS specialists. Several "outsiders" also have access to the files for special purposes, and do not appear in the organizational hierarchy shown.

The lines connecting the individuals in our organization chart represent the formal channels of communication between members of the ARIS user group. These formal channels represent one way of looking at the "connectedness"[1/] of the users. We have no evidence, however, of the general utilization of these channels. Alternatively, then, we will look at the sociology of ARIS use in terms of "who inquires for whom." We will mean by the relation "A → B" that individual "A" makes MIS/360 inquiries to produce reports for individual "B". We can then reconstruct our representation of the ARIS user group by substituting this new relationship for the formal one. Quite a different picture is obtained, as can be seen in Illustration 2.4.

A few explanatory notes are needed in the interpretation of our schematic of interpersonal inquiry. First, arrows between nodes are used to indicate "A → B". Secondly, arrows internal to nodes

---

1/ The term "connectedness" is used in the sense defined by Harary and Miller. [21]

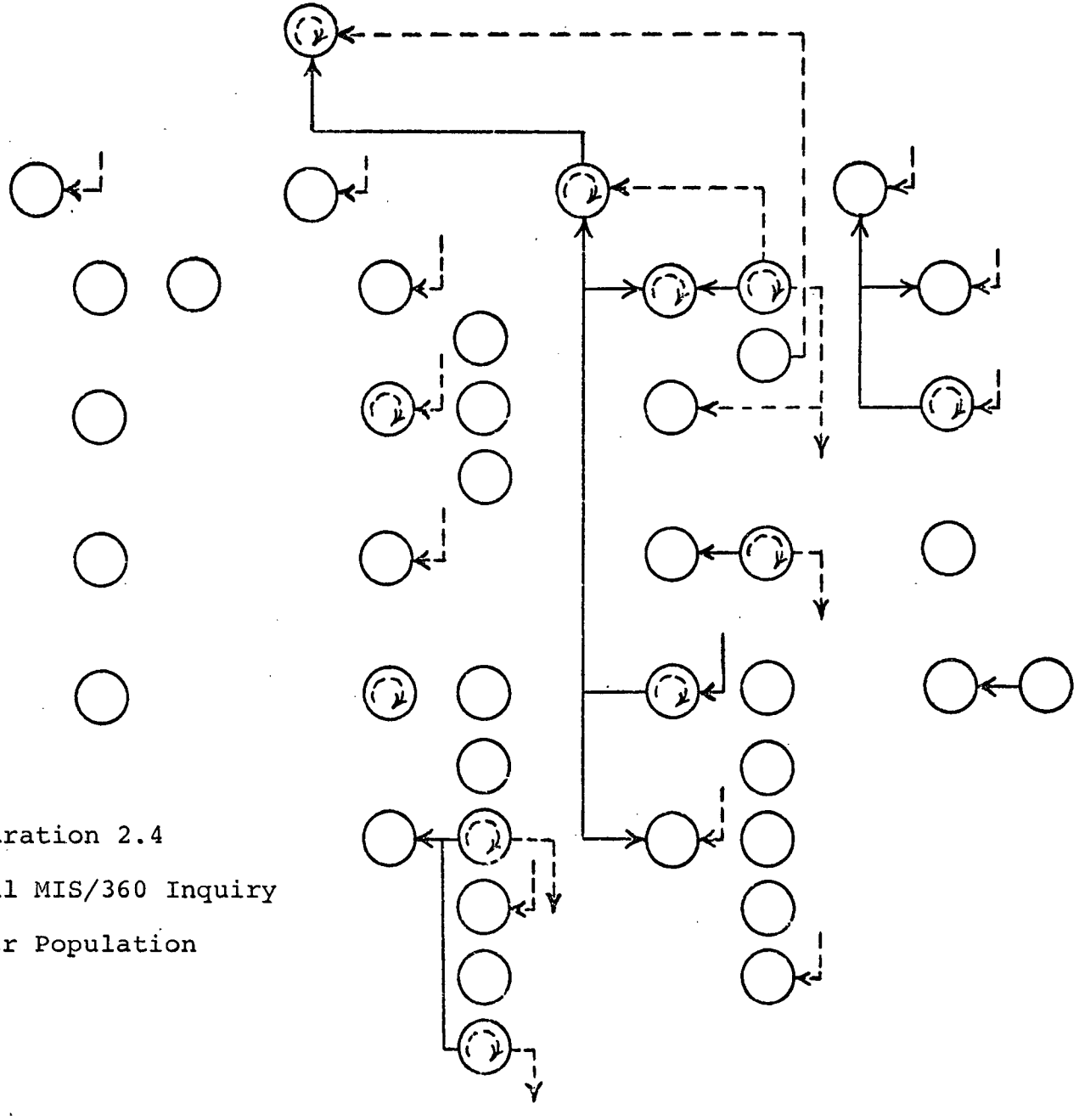

Illustration 2.4

Interpersonal MIS/360 Inquiry

ARIS User Population

are used to represent the relation "A → A", i.e. use of the terminal for self-inquiry. Solid and dotted lines indicate formal and informal channels of communication, respectively. Finally, a word or two of caution. Only first-order effects are shown; if a report is habitually passed around, this may not appear in the diagram. Also, the diagram is slightly incomplete in that several individuals did not respond to the questionnaire upon which this is based (see next section).

Nevertheless, our new "organization chart" is revealing. We see that the MIS/360 user group is relatively disconnected, for example. Sixteen individuals do not utilize MIS/360 inquiry in any way. And only the Process Quality Control Program demonstrates interpersonal involvement which extends to the manager of SQC Engineering. The Measurement Technology Program is virtually divorced from any involvement at all.

The MIS/360 user group also appears to be "open" to other members of SQC Engineering, i.e. various arrows do not have either an originating or terminating node on the diagram. To a large extent, this is misleading. Of the "inputs", some are due to clerks who operate the terminals for ARIS users. The "outputs"

(and other inputs) appear as they do primarily because of non-specific questionnaire responses.

It will be helpful to look more closely at the principal locus of MIS/360 inquiry, the Process Quality Control Program, and its manager, Mr. K. H. As we found in the previous section, K. H. is an ARIS advocate, a principal personality in our story. As can be seen from Illustration 2.4, only K. H. among the program managers uses ARIS as a route to the "ear" of Mr. T. W., Manager of SQC Engineering. Thus, in a sense, ARIS is "his system" (in the words of another program manager), and our understanding of ARIS use should be enhanced by an examination of his relationship to it.

* * *

K. H., as an ARIS proponent, has used his position as Program Manager of Process Quality Control to motivate the use of the system within SQC Engineering. According to another ARIS proponent: "We benefited an awful lot by K.'s being our program manager, because he understood it (ARIS), understood it quite well. ... He saw its importance and was willing to help us go out and fight the fight. ... He used the system. He used the system in such a way that the first-level managers reporting to him also had to use the system,

. . .[by] asking the question, 'Why? Why are you using this much manpower?' He had us each generate estimates of how we were going to use our manpower, and then he would inquire and compare the actual against that, and he'd ask the questions, not just shotgun questions, he'd ask rather probing questions. And the inference was that each of these managers reporting to him also had to be conversant, which meant that he had to use the system."

The aggressive leadership of K. H. is rather graphically illustrated by the following recollection: "I sat in on one of his staff meetings. ... He asked me to sit in and operate the terminal for him. And he had on his sheet of paper the manpower estimates by product by each of his managers. ... So he'd say, 'O.k., key in for X product by department.' Then he'd get a printout, and he'd say, 'O.k., L. W., you said you'd promise so much manpower in this area, and it shows you're over. Why?' So L. W. would say, 'Well, that extra effort is there because of failure analysis problems. R. M. has spent a lot of time on failure analysis.' (K. H. would) say, 'Oh, yeah? O.k., A., you key in detail for Department Y, and find out what activities were done by whom,' and I'd key in, and. . . it'd come out, and R. M. wasn't on there at all. So

K. H. told him, 'Look, now you guys are all managers here, we're not picking on any one of you, but you should all know what your manpower are doing. ... That's one of your main jobs, keeping in touch with your manpower.'"

K. H. describes his strategy quite openly: "What you have to do. . .is to direct their attention to certain problem situations that can be solved readily and quickly by the use of MIS/360. ... You do this for a period of time and then they automatically go to the system."

Thus, K. H. sees the problem in terms of inducing system familiarity. Classroom training has apparently failed in this regard. "We've found that . . .taking them to class and explaining to them all the good things [about] MIS/360 is an absolute waste of time. . .in the sense of getting them to use it intelligently."

On-the-job use is seen as essential, and K. H. believes the organizational climate must be manipulated to achieve successful system implementation. Managers must be led to drink from the MIS/360 waters. Appreciation follows. "I don't really care why he needs it from an overall management strategy. I've got his head down and he's soppin' at the water. I

know, from my own viewpoint, that [this] water can taste real good to a thirsty horse. ... They say you can take a horse to the water, but you can't make him drink. That's a bunch of baloney! All you've got to do is give him sugar, and, really, it's not sugar but it's salt, the outside is coated with sugar, and he sucks a few of them, and he's going to stick his neck down inside that water and he's going to drink! And he's going to enjoy it while he's doing it! So that's the management philosophy I work to on these kinds of systems."[1/]

K. H. also uses his position to encourage system use in departments other than his own. A November, 1970, memorandum to a staff member of the Purchasing Engineering Program is paraphrased as follows: "I have noted an increase of approximately 1.5 equivalent people being applied against the subject products. As these are principally recondition-products, I am concerned that we might be having some hidden quality control problems that are being reflected in the increase. I would appreciate an indication from you as to the reasons for this increase."

1/ The rhetorical excess in this statement flowed from the humorous spirit with which it was made.

In a memorandum to his fellow program managers, K. H. extolls the virtues of ARIS in the following manner: "Year-end estimates for the subject products are down 5.1 equivalent people without any substantial decrease in schedules. The use of ARIS has brought about this manpower reduction and allowed us to input a more realistic estimate to our Operating Plan."

To summarize thus far, K. H. has motivated ARIS use by raising organizational questions which can be addressed by means of the information system, and by broadcasting the good news to be found in the answers to these questions.

One last implementation technique remains to be examined. Generally speaking, a management information system is usually thought of as being adapted to a particular organizational environment. But K. H. has proceeded in part on the basis of molding the organization to the information system. In addition to raising organizational questions for ARIS, K. H. has sought to modify organizational routine and the language of management. The Operating Plan for SQC Engineering is constructed on the basis of ARIS terminology and categories, for example. According to K. H.: "We built the whole management communication channel around

the verbiage and techniques necessary to support [the] system. . .so you are constantly referring to the system. You structure it so that it's part of operating technique."

In these ways, K. H., as an ARIS proponent, seeks to encourage use of the system.

2.5 ARIS Involvement and Appreciation

Our study of ARIS use included the monitoring of the MIS/360 Inquiry History File and the distribution of a questionnaire to all authorized users. In the first case, we sought to measure the inquiry involvement of the user population. In the second, we wished to obtain measures of system appreciation and a priori involvement. (The criteria for these measures were developed in the previous chapter.) The idea, of course, was to put our model of MIS use to the test.

The Inquiry History File was monitored over a period of almost four months. Two "samples" were obtained, the first a complete record of system use during 26 working days between 7/21/70 and 9/9/70, the second a complete record of system use during the 30 working days included in the period 10/5/70 to 11/13/70. The use of two successive samples allowed us to test the pattern of use for time-transient relationships.

The research questionnaire was distributed to the ARIS users on 11/24/70. Of the 46 questionnaires mailed, 39 were returned with answers which contributed to the results. (Of the other seven, only two were not returned. The others were returned unanswered, mostly for good reasons, e.g. "this man has left the Company.")

An edited copy of the questionnaire is included as Appendix 2.2 to this chapter. The first seven items do not contribute to the measures of system appreciation and a priori involvement. Items 1 and 2 are used to measure alternative "explanations" of system use: in-class training and computer programming experience. Items 3 through 7 categorize the users according to their direct or indirect exposure to MIS/360 inquiry (and were used to construct Illustration 2.4 in the previous section).

Questionnaire items 8-23 are used to measure "MIS appreciation." Each item uses "polar opposite" valuations to establish a scale of belief with respect to some aspect of MIS inquiry. A forced-choice response within the interval defined by the opposites is taken as a relative indicator of MIS appreciation. (A "don't know" response is also permitted, and is interpreted as indicating a lack of appreciation.)

Two forms of MIS appreciation are solicited from items 8-23. The first eight items ask the respondent to indicate his "report appreciation," while the second eight seek indications of his "report-production appreciation." Roughly speaking, the idea is to obtain indicators of the perceived benefits (e.g. "timely" reports) and costs (e.g. "somewhat troublesome" terminal operation) of MIS inquiry. The final index of MIS appreciation is the average of these benefit-cost assessments.

Questionnaire items 24-33 are used to measure the a priori involvement of the ARIS users. Each item indicates the relative frequency of the respondent's initiation of change in some aspect of the design or operational state of ARIS.

The reader may refer to Appendix 2.2 to examine the individual questionnaire items. The questionnaire has been annotated to include the item scoring key and the response frequencies. The item scores are shown next to their verbal equivalents, while the response frequencies are shown as numbers in parentheses. Notes which follow the questionnaire include brief explanations of the item scaling valuations.

The indices representing our research variables can be specified formally, and we now undertake to do this. (The casual reader may thus wish to skip ahead.)

First, we let x_{ij} represent the response of individual i to questionnaire item j. The scale for "scoring" this response (i.e. assigning a numerical value to it) is, as has been stated, specified in Appendix 2.2.

A set of indices, each based on an interval scale, is operationally defined as follows:

(1) "Report Appreciation"

$$A_{i1} \equiv \frac{1}{8} \sum_{j=8}^{15} x_{ij} \qquad i = 1, ---, n$$

(2) "Report-Production Appreciation"

$$A_{i2} \equiv \frac{1}{8} \sum_{j=16}^{23} x_{ij} \qquad i = 1, ---, n$$

(3) "MIS Appreciation"

$$A_{i3} \equiv \frac{1}{16} \sum_{j=8}^{23} x_{ij} \qquad i = 1, ---, n$$

(4) "A Priori Involvement Frequency"

$$X_{i1} \equiv \frac{1}{10} \sum_{j=24}^{33} x_{ij} \qquad i = 1, ---, n$$

Two important assumptions underly the construction of these indices. First, it is assumed that the items chosen are an adequate sample from a universe of items which would indicate the relative presence or absence of the attribute in question. Secondly, it is assumed that the items are equivalent indicators of the attribute, and that they should be weighted equally in the scoring.

The second assumption might be challenged on the grounds that the item scales are unique, and that to combine them, as in averaging scores, would be to "add apples and oranges." This argument loses its force when one considers that apples and oranges may be summed in answer to the question, "How many items of fruit?" We assume only that the questionnaire items are equivalent as <u>indicators</u> of appreciation or involvement.

Nevertheless, the two assumptions do not appear to have held well for the index of a priori involvement frequency. Item 24, a "weak" indicator of involvement, dominated the scoring (see Appendix 2.2)

due to the infrequency of other involvement forms. Thus, an alternative measure of a priori involvement (i.e. its "extent" as opposed to its "frequency") was developed:

(5) "A Priori Involvement Extent"

$$X_{i2} \equiv \frac{1}{10} \sum_{j=24}^{33} \hat{x}_{ij} \qquad i = 1, ---, n$$

where

$$\hat{x}_{ij} = 1 \quad \text{if} \quad x_{ij} > 0 \qquad j = 24, ---, 33$$

$$= 0 \quad \text{otherwise}$$

Three other measures were constructed from the questionnaire:

(6) "MIS Education"

$$E_{i1} \equiv x_{i1} \qquad i = 1, ---, n$$

(7) "Programming Experience"

$$E_{i2} \equiv 0 \quad \text{if} \quad x_{i2} = \text{"no experience at all"}$$

$$\equiv 1 \quad \text{otherwise}$$

$$i = 1, ---, n$$

(8) "Mode of Use"

$$U_{il} \equiv 0 \quad \text{if} \quad x_{ij} = \text{"no"} \qquad j = 3, ---, 7$$

$$\equiv 1 \quad \text{if} \quad x_{ij} = \text{"no"} \qquad j = 3, 4, 5$$

$$\text{and} \quad x_{ij} = \text{"yes"} \qquad j = 6 \text{ or } j = 7$$

$$\equiv 2 \quad \text{if} \quad x_{ij} = \text{"yes"} \qquad j = 3, j = 4, \text{ or } j = 5$$

$$i = 1, ---, n$$

Each of the above measures was developed after surveying the questionnaire responses to see how the respondents could be effectively categorized. MIS education is measured on a ratio scale, while the other two measures are ordinal indicators only.

"Mode of Use" presumes to measure the "directness" of the user's inquiry involvement. When $U_{il} = 0$, the individual has no contact with the system as a user. When $U_{il} = 1$, he receives reports from the system, but does not produce them himself through terminal inquiry. When $U_{il} = 2$, the individual is classified as someone who uses the terminal himself.

Our measures of MIS/360 inquiry involvement can be defined as follows. Let q_{ik} represent the number of queries entered by individual i during sample working day k. Then we define:

(9) "Initial Inquiry Involvement"

$$I_{i1} \equiv \frac{1}{26} \sum_{k=1}^{26} \hat{q}_{ik} \qquad i = 1, ---, n$$

where

$$\hat{q}_{ik} = 1 \quad \text{if } q_{ik} > 0 \qquad k = 1, ---$$

$$= 0 \quad \text{otherwise}$$

and

(10) "Current Inquiry Involvement"

$$I_{i2} \equiv \frac{1}{30} \sum_{k=27}^{56} \hat{q}_{ik} \qquad i = 1, ---, n$$

Thus, our measures of inquiry involvement may be interpreted as indicating the "probability" that the client will use the MIS/360 terminal (i.e. enter at least one query) on a given working day. Other indices could obviously be used, but the interpretation is often more tenuous (e.g. does the volume of queries entered indicate curiosity or inefficient file interrogation?).

* * *

A summary of the measurement results is shown as Appendix 2.3 to this chapter. Each user is identified by a sequential identification number, and his scores on each of the above ten measures are listed.

Where no score is indicated, the measurement was not completed for some reason (e.g. the questionnaire items were left blank).

We can now examine the data, and make some rough tests of the viability of our research hypotheses. Recall the three hypotheses from the previous chapter:

For a given MIS environment:

(1) A priori involvement co-produces (indirectly) inquiry involvement.

(2) A priori involvement co-produces MIS appreciation.

(3) MIS appreciation co-produces (and is co-produced by) inquiry involvement.

We will use I_{i2} as the (current) inquiry involvement of individual "i". Similarly, we will use X_{i2} to represent his a priori involvement (extent), and A_{i3} to indicate his MIS appreciation.

Since the above variables are defined on an interval scale, we could, by assuming a multivariate normal distribution, apply correlation and regression analysis to our results. However, an inspection of the results indicates that individuals tend to be "involved" or "uninvolved" on the I_{i2} and X_{i2} scales, and that a simple classification and nonparametric analysis would

be a more modest and appropriate approach. For this reason we present the results in the form of a set of contingency tables.[1/]

First we identify the following classes for the three variables:

inquiry involvement:

$I_{i2} < .100$	"uninvolved"
$\geq .100$	"involved"

MIS appreciation:

$A_{i3} < .50$	"unappreciative"
$\geq .50$	"appreciative"

a priori involvement:

$X_{i2} \leq .100$	"uninvolved"
$> .100$	"involved"

The points of division in the classifications have been chosen so as to preserve natural groupings of the scores while distributing them among the cells of the contingency tables.

Now we consider the covariation of a priori involvement (X_{i2}) with inquiry involvement (I_{i2}):

1/ Correlations have been computed, however, and are included in Appendix 2.3.

	inquiry involvement (I_{i2})	
a priori involvement (X_{i2})	"uninvolved"	"involved"
"uninvolved"	19	5
"involved"	6	7

The table may be analyzed statistically by means of a simple chi-square test.[1/] Our null hypothesis is that there is no difference between the X_{i2} populations with respect to I_{i2}. The chi-square statistic (χ^2) was computed to be 2.82, which is significant at the .10 level. (The Fisher exact probability was computed to be .048, which is more "significant.") The null hypotheses may thus be "rejected", and we conclude that X_{i2} and I_{i2} covary. (The direction of covariation is consistent with our hypothesis, i.e. the variables increase and decrease together.)

Thus we obtain results which lend credence to the first hypothesis, that a priori involvement co-produces (indirectly) inquiry involvement. (The causality direction is, of course, assumed by our model. It is not implied by the statistical results.)

1/ All statistical tests were made using IBM's System/360 Scientific Subroutine Package (PL/I), Program Number 360A-CM-07X.

Next we inspect the covariance of the intervening variable, MIS appreciation (A_{i3}), with both types of involvement:

	MIS appreciation (A_{i3})	
a priori involvement (X_{i2})	"unappreciative"	"appreciative"
"uninvolved"	18	6
"involved"	2	11

	MIS appreciation (A_{i3})	
inquiry involvement (I_{i2})	"unappreciative"	"appreciative"
"uninvolved"	18	7
"involved"	2	10

The statistic χ^2 is computed to be 9.79 in the first case, and 7.89 in the second. Our results are thus significant in both cases at the .01 level, and the direction of covariation is as expected. The strength of these results (as opposed to the first test) also

supports our model in the sense that causality has been assumed to be "direct," rather than through an intervening variable.

Now we investigate how X_{i2} and I_{i2} covary, given A_{i3}, the intervening variable. In other words, does MIS appreciation (A_{i3}) "explain" the covariation between a priori involvement (X_{i2}) and inquiry involvement (I_{i2})? Our model suggests that it should. We thus form the following contingency tables, separating our initial table into two parts:

	MIS appreciation (A_{i3}) "unappreciative"	
	inquiry involvement (I_{i2})	
	"uninvolved"	"involved"
a priori involvement (X_{i2})		
"uninvolved"	17	1
"involved"	1	1

	MIS appreciation (A_{i3}) "appreciative"	
	inquiry involvement (I_{i2})	
a priori involvement (X_{i2})	"uninvolved"	"involved"
"uninvolved"	2	4
"involved"	5	6

These results are somewhat startling. In neither case is the covariation statistically significant. For quite different reasons in each case, however! In the first case, knowledge that $A_{i3} < .50$ is almost sufficient to imply low involvement in <u>both</u> its forms. In the second case, knowledge that $A_{i3} \geq .50$ is almost sufficient to predict (relatively) high involvement in <u>some</u> form, but nothing can be said about <u>which</u> form. Thus, for any <u>particular</u> form of involvement, MIS appreciation appears to be a necessary, but not sufficient condition. This leads us to ask how the model might be extended to provide the additional explanation now needed. We will return to this issue in the next section.

Before we do this, however, we will make some further explorations of the present data. First, we consider the possibility that two exogenous variables, MIS education (E_{i1}) and programming experience (E_{i2}), might "explain" the MIS appreciation (A_{i3}) of individual "i". Classes for E_{i1} and E_{i2} are identified as follows:

MIS Education:

$E_{i1} \leq 3$ "low"

> 3 "high"

programming experience:

$E_{i2} = 0$ "none"

$= 1$ "some"

The following contingency tables can then be formed:

	MIS appreciation (A_{i3})	
	"unappreciative"	"appreciative"
MIS education (E_{i1})		
"low"	13	7
"high"	6	10

	MIS appreciation (A_{i3})	
	"unappreciative"	"appreciative"
Programming experience (E_{i2})		
"none"	7	5
"some"	12	12

In neither case are the results statistically significant, although the χ^2 value for the first table (1.71) suggests that MIS education is at least not counter-productive in its function.

We may consider the effects of the exogenous variables taken jointly by means of the following table:

	MIS appreciation (A_{i3})	
	"unappreciative"	"appreciative"
MIS education (E_{i1}) "low" or Programming experience (E_{i2}) "none"	16	9

	MIS appreciation (A_{i3})	
	"unappreciative"	"appreciative"
MIS education (E_{i1}) "high" and Programming experience (E_{i2}) "some"	3	8

Here the value of the χ^2 statistic (2.79) is significant at the .10 level, suggesting that MIS education may be more effective when coupled with programming experience (which seems intuitively correct). Nevertheless, the results for these exogenous variables are weak when compared to the results for our postulated model.

The measure "mode of use" (U_{i1}) can also be used in the analysis of our results. This indicator provides us with a new typology of MIS use, one which allows us to consider "indirect" users who receive reports but do not personally use the terminals. Classes for U_{i1} are as follows:

Mode of Use:

U_{i1} = 0 "no use"

= 1 "indirect use"

= 2 "direct use"

We may then test the covariance of U_{i1} with MIS appreciation (A_{i3}). The contingency table takes a 3x2 form:

	MIS appreciation (A_{i3})	
	"unappreciative"	"appreciative"
Mode of Use (U_{i1})		
"no use"	9	0
"indirect use"	7	6
"direct use"	4	11

The value of the χ^2 statistic computes to be 12.18, which is significant at the .01 level for two degrees of freedom. This result suggests that indirect exposure to MIS inquiry may provide a route to MIS appreciation.

This completes our analysis of ARIS involvement and appreciation. It is possible, of course, to examine our results more closely or more extensively than has been shown. To facilitate this,

Appendix 2.3 contains a full table of results, as well as notes pertaining to data anomolies. A correlation analysis is also included, together with an interpretation of its findings. These details have been relegated to an Appendix because they do not add substantially to the more cursory presentation made here.

2.6 Summary and Conclusions

We find our research hypotheses to be supported by the results of the study. Each of the three hypotheses with which we began was substantiated by our data gathering and statistical analysis. However, the study has also provided a few surprises which must be accounted for.

We have found that MIS appreciation "explains" MIS involvement (and vice versa), but that an explanation of the <u>form</u> of involvement is lacking. Individuals who indicate MIS appreciation involve themselves with the system as inquirers and/or designer-implementers. Individuals who indicate a lack of MIS appreciation involve themselves not at all. But of those who appreciate the system, what motivates one man toward inquiry involvement and another toward a priori involvement? Nothing in our limited model provides the answer.

Of course, our initial idea was that a priori involvement led to inquiry involvement, i.e. that users of an MIS must have participated in the design. This was much too simple a notion. In the first place, it raises the question of why an individual would involve himself in the MIS design. Presumably, he would not freely do so without some prior appreciation of the system. The secret to an understanding of this situation lies in the word "freely." As Professor Thomas Cowan has pointed out in a conversation, each of the three principal measures in our model is a measure of the exercise of individual freedom. No manipulating factor has been included. Thus, there is no "beginning" to the causal argument. We will return to this problem shortly. For the moment we are limited to the following inference from our tests:

(2.3) MIS appreciation co-produces (and is co-produced by) MIS involvement.

Another inference from our questionnaire and interview results will be helpful to us:

(2.4) MIS involvement is interpersonal as well as personal.

The point here is that our original model is based on the psychology and behavior of an individual. But as the notes on ARIS sociology have revealed, interpersonal

use of the system is very important. This provides us with a potential explanation for individual MIS appreciation and involvement: one individual can motivate and manipulate another.

Now, we can reflect on the development of ARIS as described earlier from an "evolutionary perspective." It is clear that the design and implementation of ARIS can be credited to a very few individuals, a social group which grew and developed with the system itself. This was not simply a group of those who "appreciated" the system. Rather it was a group of the truly committed; perhaps "devoted" is also an appropriate characterization. This was a group of the "true believers," and it vigorously sought to extend its faith. The a priori involvement of this "techno-proponent group" was based in part on cultivating an MIS appreciation among the unfaithful.

The idea of a techno-proponent group can thus be offered as a conceptual byproduct of the study:

(2.5) A techno-proponent group is a social group whose objective is the application of a particular technology to the solution of organizational or social problems.

Thus, the ARIS proponents can be characterized as acting in concert to apply computer resources to the solution of SQC Engineering manpower planning problems.

The very concept of ARIS was born in the minds of the techno-proponent group. Thus, we note that

(2.6) An MIS is the brainchild (design product) of a techno-proponent group.

and that

(2.7) A client group is perceived by the techno-proponent group to be the beneficiary of the MIS.

The words of ARIS proponent A. W. are recalled to mind: "At the time we thought -- who is the system for? It's for management people, mainly for management people. . ."

It is the MIS involvement of the techno-proponent group which provides us with the "manipulating factor" excluded from the simple model of individual MIS appreciation and involvement. Given their original technological commitment, the ARIS proponents worked diligently to provide design features which would encourage system use. Then they used classroom training, intra-organizational memoranda and meetings, modification of organizational procedures, all for this same purpose: achieving system utilization. Thus, we note that:

(2.8) The a priori involvement of the techno-proponent group is directed toward motivating the inquiry involvement of the client group.

A high rate of system utilization is taken as a favorable sign of design success.

But the interesting question, of course, is how this motivation may be achieved. Our study suggests that two general methods are employed, one well known, the other much less so:

(2.9) The techno-proponent group motivates the client group by (i) "selling" the MIS; and (ii) raising organizational decision problems which may be addressed by the MIS.

In the first case, the ARIS proponents seek to modify the MIS appreciation of the client group directly, e.g. by "sales pitch" proposals and "educational" training sessions. The attempt is to transplant the MIS appreciation of the techno-proponent to the uncommitted client. The underlying feeling of the designer is: if only they appreciated it they would use it!

The second case is much more subtle. Here the techno-proponent group works to create an organizational environment which is supportive of the

MIS. Since the report-producing component of the MIS provides "facts," the designers motivate use of the system by raising questions which can be addressed via these facts. If this sounds contrary to reason, i.e. as if putting a cart before the horse, it is not entirely so. For example, by browsing through the ARIS files, an individual may discover a "variance" between indices of planned and actual work activity. This "fact" suggests the question "why?" or "do we have a problem?" Further inquiry into the components of these indices may provide a plausible answer. Thus, thoughtful question-raising can be an important managerial task.

Of course, a simple raising of organizational decision problems may not suffice to motivate MIS inquiry involvement. The problems must be considered compelling to those who face a variety of demands on their time. Thus, the managerial authority of K.H., as a leader of the ARIS techno-proponent group, carried import to problems which he defined.

(2.10) The techno-proponent group employs organizational leverage to secure a supportive MIS environment.

The institution of new organizational routine was also a method for applying this organizational leverage.

The development of the Operating Plan for SQC Engineering, a procedure requiring adherence to ARIS terminology, was an example of bending the organization to its MIS design.

As was stated earlier, an MIS originates and develops within an evolutionary context, a constantly changing milieu of organizational and technological possibilities. (assertion 2.1, page 65) The techno-proponent group thus works to realize those possibilities which support the MIS. Not to do so would leave the fate of the MIS to chance, and to an indifferent (or hostile) social environment. The continuing survival of ARIS will therefore reflect the sustained commitment of its techno-proponent group. (assertion 2.2, page 65)

* * *

Our study of ARIS suggests that the model of individual appreciation and involvement should be extended to an interpersonal theory, one which permits us to explain one individual's behavior in terms of another's. This will be taken up in the final chapter.

Appendix 2.1

ARIS Data File Structures

Activity Status File:

Each record contains the number of hours charged by a given employee to a particular activity during a given week.

Data Element		Description
1.	Activity Code	Four-character identifier
2.	Machine Type	Two-character identifier
3.	Employee Serial Number	Six-digit identifier
4.	Employee Skill Code	Two-digit identifier
5.	Week-ending Date	YYMMDD format
6.	Mission Code	Four-digit identifier
7.	Employee Name	
8.	Activity Description	
9.	Machine Type Description	
10.	Hours	XX.X. format

Activity History File:

Each record contains the number of man-hours of a particular employee skill charged by a given department to a particular activity during a given month.

Data Element	Description
1. Activity Code	
2. Machine Type	
3. Department Number	Three-digit identifier
4. Employee Skill Code	
5. Month Date	YYMM format
6. Activity Description	
7. Man-month Estimate	XXX.XX format
8. Machine Type Description	
9. Hours	XXXX.X format

M.I.S. RESEARCH QUESTIONNAIRE

Notes

1. The results from this questionnaire will be presented to [redacted] management in the form of summary statistics only. Individual replies are confidential.

2. Try to answer each question.

3. Written comments are encouraged. Please clarify your responses as needed.

4. When you have finished, return the questionnaire to me in the attached envelope.

1. How many in-class hours have you spent being educated in the use of MIS/360? (check one of the following)

   (1) None. (7)

   (2) One or less, more than none. (0)

   (3) Three or less, more than one. (14)

   (4) Five or less, more than three. (15)

   (5) More than five. (2)

2. What is your experience in writing computer programs? (check one of the following)

   (1) No experience at all. (15)

   (2) Have classroom experience only. (13)

   (3) Have written computer programs as part of job, but have not worked as computer programmer. (7)

   (4) Have worked as computer programmer. (3)

*****

How do <u>you</u> make use of MIS/360?

3. I make MIS/360 inquiries for my own decision-making purposes. I use the terminal(s) myself.

   (1) Yes. (13)

   (2) No. (22)

4. I make MIS/360 inquiries to produce [redacted] reports for my management.

   (1) Yes. (11)

   (2) No. (27)

   If "yes," who in your management? _____

5. I make MIS/360 inquiries to produce [redacted] reports for persons other than myself or my management.

   (1) Yes. (7)

   (2) No. (31)

   If "yes," what other persons? _____

6. My subordinates make MIS/360 inquiries to produce [redacted] reports for me.

   (1) Yes. (17)

   (2) No. (21)

   If "yes," which subordinates? _____

7. Persons other than my subordinates or myself make MIS/360 inquiries to produce [redacted] reports for me.

   (1) Yes. (13)

   (2) No. (25)

   If "yes," what other persons? _____

*****

Please make the following evaluations with respect to your own decision making problems, and with respect to the [redacted] reports produced by you or for you.

8. For me, the [redacted] reports are

(9)	(10)	(7)	(1)	(0)	(7)
very timely .9	somewhat timely .7	neither timely nor untimely .5	somewhat untimely .3	very untimely .1	don't know .0

9. For me, the [redacted] data is

(11)	(12)	(1)	(3)	(2)	(6)
very relevant .9	somewhat relevant .7	neither relevant nor irrel-evant .5	somewhat irrel-evant .3	very irrel-evant .1	don't know .0

10. For me, the [redacted] information is

(1)	(3)	(8)	(8)	(7)	(7)
very redundant .1	somewhat redundant .3	neither redundant nor unique .5	somewhat unique .7	very unique .9	don't know .0

11. For me, the [redacted] data is

(3)	(8)	(3)	(9)	(7)	(6)
very inaccurate .1	somewhat inaccurate .3	neither inaccurate nor accurate .5	somewhat accurate .7	very accurate .9	don't know .0

12. For me, the [redacted] data is

(2)	(4)	(3)	(10)	(10)	(7)
very misinstructive (misleading) .1	somewhat misinstructive .3	neither misinstructive nor instructive .5	somewhat instructive .7	very instructive .9	don't know .0

13. For me, the [redacted] reports are

(1)	(3)	(5)	(14)	(6)	(6)
very diffuse (not to the point) .1	somewhat diffuse .3	neither diffuse nor concise .5	somewhat concise .7	very concise (to the point) .9	don't know .0

14. For me, the meaning of the [redacted] data is

(8)	(8)	(9)	(3)	(2)	(5)
very unambiguous (clear) .9	somewhat unambiguous .7	neither unambiguous nor ambiguous .5	somewhat ambiguous .3	very ambiguous (unclear) .1	don't know .0

15. For me, the [redacted] reports are

(14)	(11)	(2)	(3)	(0)	(6)
very readable .9	somewhat readable .7	neither readable nor unreadable .5	somewhat unreadable .3	very unreadable .1	don't know .0

*****

Please make the following evaluations with respect to your own use (or non-use) of MIS/360.

16. For me, the MIS/360 query language is

(6)	(13)	(5)	(3)	(0)	(10)
very efficient .9	somewhat efficient .7	neither efficient nor inefficient .5	somewhat inefficient .3	very inefficient .1	don't know .0

17. For me, the MIS/360 operating schedule (10-5, daily) is

(3)	(6)	(5)	(11)	(1)	(11)
very convenient .9	somewhat convenient .7	neither convenient nor inconvenient .5	somewhat inconvenient .3	very inconvenient .1	don't know .0

18. For me, the operation of the MIS/360 system is

(3)	(13)	(5)	(6)	(0)	(9)
very reliable .9	somewhat reliable .7	neither reliable nor unreliable .5	somewhat unreliable .3	very unreliable .1	don't know .0

19. For me, the use of the 2260 and 2741 terminals is

(3)	(7)	(7)	(12)	(2)	(5)
very troublesome .1	somewhat troublesome .3	neither troublesome nor untroublesome .5	somewhat untroublesome .7	very untroublesome .9	don't know .0

20. For me, the MIS/360 report formatting capabilities are

(7)	(12)	(3)	(4)	(1)	(9)
very adequate .9	somewhat adequate .7	neither adequate nor inadequate .5	somewhat inadequate .3	very inadequate .1	don't know .0

21. For me, the average on-line response to an MIS/360 terminal inquiry is

(5)	(16)	(1)	(4)	(0)	(10)
very prompt .9	somewhat prompt .7	neither prompt nor unprompt .5	somewhat unprompt .3	very unprompt .1	don't know .0

22. For me, the MIS/360 Users Guide is

(3)	(14)	(1)	(3)	(2)	(13)
very valuable .9	somewhat valuable .7	neither valuable nor valueless .5	somewhat valueless .3	very valueless .1	don't know .0

23. Relative to my needs for systems and programming support of MIS/360, the [redacted] Systems and Programming Group is

(6)	(8)	(4)	(1)	(0)	(17)
very cooperative .9	somewhat cooperative .7	neither cooperative nor uncooperative .5	somewhat uncooperative .3	very uncooperative .1	don't know .0

*****

24. How frequently (on the average) do you complete a weekly Activity Reporting Card for yourself?

(18)	(0)	(0)	(1)	(19)
once a week 1.0	twice a month .50	once a month .25	once in two months .125	never .0

25. How frequently (on the average) do you complete Activity Description Cards or [redacted] Description Cards to update the [redacted] File?

(2)	(2)	(0)	(2)	(31)
once a week 1.0	twice a month .50	once a month .25	once in two months .125	never .0

26. How frequently (on the average) do you initiate changes to the content or format of inputs to the [redacted] program?

(3)	(0)	(2)	(2)	(30)
once a week	twice a month	once a month	once in two months	never
1.0	.50	.25	.125	.0

27. How frequently (on the average) do you initiate changes to the update programs for the [redacted] files?

(1)	(0)	(3)	(3)	(29)
once a week	twice a month	once a month	once in two months	never
1.0	.50	.25	.125	.0

28. How frequently (on the average) do you update the [redacted] file from a terminal?

(1)	(1)	(1)	(1)	(34)
once a week, or more	twice a month	once a month	once in two months	never
1.0	.50	.25	.125	.0

29. How frequently (on the average) do you initiate changes to the content or format of the [redacted] files?

(3)	(0)	(1)	(3)	(29)
once a week	twice a month	once a month	once in two months	never
1.0	.50	.25	.125	.0

30. How frequently (on the average) do you initiate changes to the MIS/360 programs?

(0)	(0)	(0)	(1)	(37)
once a week	twice a month	once a month	once in two months	never
1.0	.50	.25	.125	.0

31. How frequently (on the average) do you initiate changes to the File Description or Report Description tables for the [redacted] files?

(0)	(1)	(0)	(3)	(33)
once a week	twice a month	once a month	once in two months	never
1.0	.50	.25	.125	.0

32. How frequently (on the average) do you initiate a written communication (e.g. a memorandum, report, or newsletter) for the purpose of educating others in the use of MIS/360?

(0)	(0)	(2)	(4)	(31)
once a week, or more	twice a month	once a month	once in two months	never
1.0	.50	.25	.125	.0

33. How frequently (on the average) do you initiate a meeting (either formal or informal) for the purpose of educating others in the use of MIS/360?

(0)	(0)	(3)	(4)	(30)
once a week, or more	twice a month	once a month	once in two months	never
1.0	.50	.25	.125	.0

*****

That's all there is. Thank you very much.

Notes on Questionnaire:

(i) The items measuring MIS appreciation (items 8-23) discriminated effectively among the user population. That is, the marginal totals indicate an effective distribution of respondent scores.

(ii) The items measuring a priori involvement (items 24-33) were less effective. In part, this reflected the common lack of involvement of most respondents.

(iii) Because it was organizationally "required", a substantial number of individuals participated frequently in data origination (see item 24) although they were otherwise a priori uninvolved. Thus our original measure of a priori involvement (X_{i1}) was judged to be distorted, and a second measure (X_{i2}) was introduced as a substitute. (See Section 2.5 of this chapter.)

(iv) MIS appreciation may be thought of as having "knowledge" and "valuation" components. The scoring of questionnaire items 8-23 may be explained in these terms. An appreciation score is taken as the "product" of a valuation and (implicit or explicit) expression of knowledge.

Valuation scores of .9, .7, .5, .3, and .1 are based upon an arbitrary .0 to 1.0 scale range, subdivided into five intervals, assumed to be "equal." A "don't know" response is scored .0 on a corresponding knowledge scale, and it is assumed that to not check "don't know" is to indicate "know", scored 1.0. Thus, a valuation response results in an appreciation score identical to the valuation score, and a "don't know" response results in an appreciation score of .0.

(v) The scoring of the indicators of a priori involvement (items 24-33) requires little explanation. Each item is based upon a relative frequency range of "never" (arbitrarily scored .0) to "once a week" (arbitrarily scored 1.0). The scoring of intermediate responses (e.g., "once a month", scored .25) is then obvious.

(vi) The indicator of MIS education (item 1) was scored according to the midpoints of the intervals defined. Thus, for example, "one or less, more than none" was scored .5. An exception was "more than five", which was scored 6.

Appendix 2.3

Data Summary and Analysis

In this appendix we present a complete listing of our data for each of the 10 measures defined, together with a series of notes to guide the interpretation.

In addition, a correlation analysis is made for those variables defined on an interval scale, and the results are commented upon with regard to their implications for our theory.

Data Summary:

User No. i	A_{i1}	A_{i2}	A_{i3}	X_{i1}	X_{i2}	E_{i1}	E_{i2}	U_{i1}	I_{i1}	I_{i2}
01	.90	.67	.79	.00	.00	4	1	2	.038	.000
02	.78	.50	.64	.13	.20	4	1	2	.384	.200
03	.90	.80	.85	.20	.70	0	1	2	.423	.267
04	.50	.48	.49	.10	.10	4	0	0	.000	.000
05	.00	.00	.00	.10	.10	0	0	0	.000	.000
06	.00	.00	.00	.00	.00	0	1	0	.000	.000
07	.19	.43	.31	.10	.10	2	1	0	.000	.000
08	.70	.50	.60	.00	.00	2	0	1	.384	.233
09	.00	.00	.00	.10	.10	0	1	0	.000	.000
10	.78	.05	.42	.01	.10	2	1	1	.000	.000
11	.73	.50	.62	.10	.10	4	0	1	.000	.133
12	.36	.45	.41	.10	.10	0	1	1	.000	.000
13	.00	.01	.01	.13	.13	0	0	0	.000	.000
14	.48	.15	.32	.10	.10	4	1	2	.000	.000
15	.46	.70	.58	.01	.10	6	1	2	.000	.000
16	.55	.21	.38	.10	.10			1	.000	.000
17	.63	.00	.32	.01	.10	2	1	1	.000	.000
18	.36	.51	.44	.01	.10	4	0	0	.000	.000
19									.000	.000
20	.70	.73	.72	.38	.50	2	1	1	.000	.000
21	.00	.68	.34	.00	.00	4	1	1	.000	.000
22	.50	.24	.37	.01	.10	2	0	1	.038	.033
23	.41	.35	.38	.00	.00	2	0	2	.000	.133
24	.65	.33	.49	.00	.00	2	0	2	.115	.033
25	.70	.55	.63	.04	.30	4	1	1	.000	.367

(continued next page)

i	A_{i1}	A_{i2}	A_{i3}	X_{i1}	X_{i2}	E_{i1}	E_{i2}	U_{i1}	I_{i1}	I_{i2}
26				.00	.00	2	1		.000	.000
27	.18	.26	.22	.10	.10	4	0	0	.000	.000
28	.82	.64	.73	.05	.20	4	1	2	.038	.100
29	.83	.65	.74	.13	.30	2	0	2	.000	.033
30	.68	.70	.69	.08	.40	4	0	2	.000	.000
31	.56	.24	.40	.10	.10	2	1	0	.000	.000
32	.68	.23	.46	.00	.00	4	1	1	.000	.000
33									.000	.000
34	.61	.53	.57	.00	.00	2	1	2	.000	.233
35									.000	.000
36									.000	.000
37	.90	.80	.85	.41	1.00	4	1	2	.308	.433
38									.000	.000
39	.75	.80	.78	.50	.50	4	1	2	.000	.000
40									.000	.000
41	.60	.41	.51	.16	.50	0	0	1	.000	.000
42	.80	.58	.69	.31	.67	6	1	2	.769	.867
43						4	0	2	.000	.000
44	.48	.45	.47	.33	.40	2	1	2	.000	.600
45									.000	.000
46	.83	.68	.76	.00	.00	2	1	2	.000	.333

Notes on Data:

(i) Of the 46 individuals with MIS/360 security codes permitting access to the ARIS files, 39 returned questionnaires fully or partially answered. Of the seven others, three (users 33, 35, and 36) were no longer with the organization when the questionnaire was distributed, two (users 19 and 45) declined to answer the questionnaire for personal reasons, and two (users 38 and 40) failed to return the questionnaire.

(ii) Several respondents (users 16, 26, and 43) returned questionnaires with incomplete or misconstrued responses which resulted in measures not being scored. In other cases, individual questionnaire items were left blank or disallowed, and indices were computed without their inclusion.

(iii) Two types of inconsistencies were found in the data measuring inquiry involvement (I_{i1} and I_{i2}) and type of use (U_{i1}). In the first case, a questionnaire respondent indicated no use or indirect use ($U_{i1} = 0$ or 1), but the history log

showed active use (I_{i1} or $I_{i2} > 0$). In the second case the respondent indicated direct use ($U_{i1} = 2$), but the log showed no use (I_{i1} and $I_{i2} = 0$). Four inconsistencies exist of the first type, and five of the second. Some of the explanations follow:

(a) User 39 (an inconsistency of the second type) made inquiries for User 25 (an inconsistency of the first type) using User 25's access code. User 25 is User 39's manager, organizationally.

(b) User 44 has used the access code of User 8 (an inconsistency of the first type) to make inquiries for a third individual who, in turn, prepared reports for User 8.

(c) A clerk makes all the inquiries for User 11 (an inconsistency of the first type).

Thus we see that our measure of inquiry involvement may reflect indirect use of MIS/360 rather than direct use. Or it may reflect non-use, where, in fact, the individual inquires under the name of another. We might justifiably re-score our data to account for these anomolies.

A scanning of the data indicates that our conclusions would thereby be strengthened. However, a more conservative action is to leave the data as it is. In this way, the tests of our hypotheses, working against the neutralizing effects of the measurement "errors", are more persuasive. This is what I have elected to do.

* * *

Correlation Coefficients:

	A_{i1}	A_{i2}	A_{i3}	I_{i1}	I_{i2}	E_{i1}	X_{i1}	X_{i2}
A_{i1}		.58		.38	.38	.37	.23	.43
A_{i2}				.28	.33	.47	.38	.49
A_{i3}				.37	.40	.47	.34	.51
I_{i1}					.69	.22	.31	.50
I_{i2}						.25	.38	.51
E_{i1}							.08	.11
X_{i1}								
X_{i2}								

Notes on Correlation Data:

(i) The above correlation coefficients were computed by means of IBM's System/360 Scientific Subroutine Package (PL/I), Program Number 360A-CM-07X.

(ii) Only the variables measured on an interval scale are included above. The variables E_{i2} and U_{i1}, both ordinal measures, are thus excluded.

(iii) Several of the variables are computationally dependent (e.g. A_{i1} and A_{i3}), and no correlation coefficients are shown for these cases.

(iv) If we assume any two of the above (independently computed) variables to be statistically related according to a bivariate normal distribution, the regression of one variable on the other will be linear. The F-test[1/] may then be used to test the null hypothesis that the slope of the regression line is zero (that knowledge of the independent variable will not assist in predicting the value of the dependent variable). If the null hypothesis is rejected we conclude that the variables are "related" in a manner analogous to the chi-square tests made earlier.

1/ The formula

$$F_{1,N-2} = \frac{r^2}{1 - r^2} (N - 2)$$

is used where
r is the correlation coefficient and
N the sample size. (N = 36, in our case.)

(v) The coefficients $r(X_{i2}, I_{i2}) = .51$, $r(X_{i2}, A_{i3}) = .51$, and $r(A_{i3}, I_{i2}) = .40$ are significant at precision levels of .01, .01, and .05 respectively, by application of the F-test. These results support our three principal hypotheses, although the values of the coefficients indicate low predictive usefulness.

(vi) The exogenous variable E_{i1} (MIS education) correlates significantly (at the .01 level) with A_{i3} (MIS appreciation), but not with X_{i2} (a priori involvement extent) nor with I_{i2} (current inquiry involvement). This result might indicate that classroom training is useful for effecting receptive individual attitudes, but that something further is needed to generate actual involvement.

(vii) The predictive superiority of X_{i2} to X_{i1} as a measure of a priori involvement is evident by an inspection of their respective correlation coefficients.

(viii) The relatively high correlation $R(I_{i1}, I_{i2}) = .69$ between prior inquiry involvement and current inquiry involvement indicates that our observations of the MIS during the second ("current") period are of more than transitory phenomena.

BEST SELLERS

FROM NATIONAL TECHNICAL INFORMATION SERVICE

NTIS

State Implementation Plan Emission Regulations for Sulfur Oxides: Fuel Combustion
PB-251 174/PAT 82 p PC$5.00/MF$3.00

Compilation of Air Pollutant Emission Factors. Supplement No. 6
PB-254 274/PAT 59 p PC$4.50/MF$3.00

Energy-Economy Relationships
PB-255 171/PAT 313 p PC$9.75/MF$3.00

Environmental Impacts of Virgin and Recycled Steel and Aluminum
PB-253 487/PAT 124 p PC$5.50/MF$3.00

Final Generic Environmental Statement on the Use of Recycle Plutonium in Mixed Oxide Fuel in Light Water Cooled Reactors—Health, Safety and Environment. Executive Summary
PB-256 487/PAT 33 p PC$4.00/MF$3.00

Regional Comparison of Savings from Various Residential Energy Conservation Strategies
ORNL-TM-5146/PAT 70 p PC$4.50/MF$3.00

Residential Hot Water Solar Energy Storage Subsystems
PB-252 685/PAT 117 p PC$5.50/MF$3.00

Directory of Federal Energy Data Sources. Computer Products and Recurring Publications
PB-254 163/PAT 84 p PC$5.00/MF$3.00

Quality Assurance Handbook for Air Pollution Measurement Systems. Volume I. Principles
PB-254 658/PAT 379 p PC$10.75/MF$3.00

Uranium Reserves, Resources, and Production
PB-254 896/PAT 18 p PC$3.50/MF$3.00

National Petroleum Product Supply and Demand, 1976-1978
PB-254 969/PAT 249 p PC$8.00/MF$3.00

Scientific and Technical Data Base for Criteria and Hazardous Pollutants—1975 ERC/RTP Review
PB-253 942/PAT 464 p PC$12.00/MF$3.00

Markets and Technology for Recovering Energy from Solid Waste
PB-253 326/PAT 37 p PC$4.00/MF$3.00

Evaluation of Pollution Control in Fossil Fuel Conversion Processes
PB-255 842/PAT 306 p PC$9.75/MF$3.00

Common Environmental Terms. A Glossary
PB-254 630/PAT 25 p PC$3.50/MF$3.00

Availability of Conventional Energy Resources Materials—Coal
PB-255 798/PAT 17 p PC$3.50/MF$3.00

HOW TO ORDER

When you indicate the method of payment, please note if a purchase order is not accompanied by payment, you will be billed an additional $5.00 *ship and bill* charge. And please include the card expiration date when using American Express.

Normal delivery time takes three to five weeks. It is vital that you order by number or your order will be manually filled, insuring a delay. You can opt for *airmail delivery* for $2.00 North American continent; $3.00 outside North American continent charge per item. Just check the *Airmail Service* box. If you're really pressed for time, call the NTIS Rush Handling Service (703) 557-4700. For a $10.00 charge per item, your order will be airmailed within 48 hours. Or, you can pick up your order in the Washington Information Center & Bookstore or at our Springfield Operations Center within 24 hours for a $6.00 per item charge.

You may also place your order by telephone or if you have an NTIS Deposit Account or an American Express card order through TELEX. The order desk number is (703) 557-4650 and the TELEX number is 89-9405.

Thank you for your interest in NTIS. We appreciate your order.

METHOD OF PAYMENT

- ☐ Charge my NTIS deposit account no. _____
- ☐ Purchase order no. _____
- ☐ Check enclosed for $_____
- ☐ Bill me. Add $5.00 per order and sign below. (Not available outside North American continent.)
- ☐ Charge to my American Express Card account number

Card expiration date_____

Signature _____

☐ Airmail Services requested

NAME_____

ADDRESS_____

CITY, STATE, ZIP_____

Item Number	Quantity		Unit Price*	Total Price*
	Paper Copy (PC)	Microfiche (MF)		

All prices subject to change. The prices above are accurate as of 2/77 .

Foreign Prices on Request.

Sub Total	
Additional Charge	
Enter Grand Total	

Clip and mail to:

NTIS

National Technical Information Service
U.S. DEPARTMENT OF COMMERCE
Springfield, Va. 22161
(703) 557-4650 TELEX 89-9405